

इंटरनेट

मानक

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“जानने का अधिकार, जीने का अधिकार”

Mazdoor Kisan Shakti Sangathan

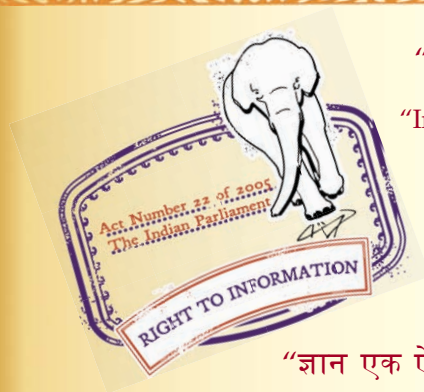
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”

Jawaharlal Nehru

“Step Out From the Old to the New”

IS 15548 (2005, Reaffirmed 2010): Hydrofluorocarbon
(HFC-134a) -- Code of Safety. ICS 13.300 : 71.080.20



“ज्ञान से एक नये भारत का निर्माण”

Satyanarayan Gangaram Pitroda

“Invent a New India Using Knowledge”



“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”

Bhartrhari—Nitiśatakam

“Knowledge is such a treasure which cannot be stolen”

REAFFIRMED

— 2010

IS 15548 : 2005

भारतीय मानक
हाइड्रोफ्लूरोकार्बन (एचएफसी-134ए) — रीति संहिता

Indian Standard
HYDROFLUOROCARBON (HFC-134a) —
CODE OF SAFETY

ICS 13.300; 71.080.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BHADUR SHAH ZAFAR MARG
NEW DELHI 110002

February 2005

Price Group 4

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Industrial Safety and Chemical Hazards Sectional Committee had been approved by the Chemical Division Council.

Hydrofluorocarbons (HFCs) are categories of synthetic chemicals that are being used as alternatives to the ozone depleting substances (ODS), which are being phased out under the Montreal Protocol and Clean Air Act amendment of 1990. Because HFCs do not directly deplete the stratospheric ozone layer, they are not controlled by Montreal Protocol.

These compounds, however, along with sulfur hexafluoride are potent greenhouse gases. In addition to having high global warming potentials, many HFC's have extremely long atmospheric life times, resulting in their essentially irreversible accumulation in atmosphere.

HFC-134a is an ozone friendly CFC substitute. The ozone layer in the stratosphere which protects the earth from ultraviolet radiation from the Sun is getting depleted by various chemicals/substances released in the atmosphere including chlorofluoro carbons (CFC) used in several industries such as refrigeration, air conditioning, electronics, foams etc. Montreal Protocol to which India became a signatory in 1992, prohibits the use of CFCs beyond the year 2010, HFC-134a is one of the recommended CFC substitute in refrigeration, air conditioning and aerosol Industries and is a much preferred one for several technical, economic and safety reasons.

There is no standard on this subject published by ISO. This standard has been prepared indigenously based on the available data and information. In preparation of this code considerable assistance has been derived from the following :

- a) Hydrocarbon Plant & Storage Safety, prepared for The World Bank 1 day Aerosol Seminar, New Delhi, April 1993 by Ing Jose Luis Corona, The Mexican Aerosol Institute & Geno Nardini, World Bank OORG Aerosol Consultant.
- b) Reducing the Consumption of Ozone Depleting Substances in India Phase I: The Cost of Complying with the Montreal Protocol by Touche Ross, Management Consultant & Gremer & Warner.
- c) Montreal Protocol, 1991 Assessment Report of the Economic Options Committee, December 1991.
- d) Ozone Depletion FAQ Part I, Introduction to the Ozone Layer, University of Colorado, Boulder, December 1997.
- e) The Chemistry of Fluorine and Its Compounds—H.J. Emeleus, Academic Press, New York, London 1969.
- f) Technical Progress on Protecting the Ozone Layer, Technical Options Committee, December 1991, United Nations Environment Programme.
- g) Technical Brochure on Genetron 134a by Allied Signal Inc. Morristown, NJ.
- h) Technical Information on HFC-134a by Du Pont.
- j) Material Safety Data Sheet for Floron 134a , SRF Limited, Fluorochemicals Division.
- k) Transport Emergency Card (TREM Card) for HFC-134a, SRF Ltd.
- m) Accident Prevention — A Workers Educational Manual, Dialogue Publications, First Indian Reprint, 1985.
- n) Recommendations on the Transport of Dangerous Goods, 9 th Revised edition, United Nations, Geneva, 1995.
- p) Refrigerant Safety, James M. Calm, P.E. Member Ashrae EPA, United States Environmental Protection Agency.
- q) Protecting the Ozone Layer, Vol. 1 Refrigerant, United Nations Publications, First Edition, 1992.

The composition of the Committee responsible for formulation this standard is given in Annex A.

Indian Standard

HYDROFLUOROCARBON (HFC-134a) — CODE OF SAFETY

1 SCOPE

This standard covers general information and properties of HFC-134a, the nature of hazards associated with it and essential information on personal protective equipment, storage, handling, labelling, transportation, spillage/leakage, waste disposal/recycling, training, fire fighting and fire prevention, health monitoring and first aid.

2 REFERENCE

The standard given below contains provisions, which through reference in this text, constitutes provisions of this standard. At the time of publication, the edition indicated was valid. All standards are subject to revisions, and parties to agreement based on this standard are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below:

<i>IS No.</i>	<i>Title</i>
4155 : 1966	Glossary of terms relating to chemical and radiation hazards and hazardous chemicals

3 TERMINOLOGY

For the purpose of this standard the definitions given in IS 4155 shall apply.

4 GENERAL INFORMATION AND PROPERTIES**4.1 General Information**

4.1.1	<i>Chemical Name</i>	1,1,1,2-Tetrafluoro ethane
4.1.2	<i>Common Name</i>	Hydrofluorocarbons/ HFC-134a / R-134a
4.1.3	<i>Molecular Formula</i>	CF ₃ CH ₂ F
4.1.4	<i>Molecular Mass</i>	102.031
4.1.5	<i>Class</i>	Non-flammable gas
4.1.6	<i>CAS Registry No.</i>	811-97-2
4.1.7	<i>UN Number</i>	3159

4.2 Physical Properties

4.2.1	<i>Description</i>	Colourless liquefied gas
4.2.2	<i>Boiling Point at 1 Atm</i>	-26.18°C

4.2.3	<i>Freezing Point</i>	-103.3°C
4.2.4	<i>Flammability</i>	Non-flammable
4.2.5	<i>Critical Temperature</i>	101.1°C
4.2.6	<i>Critical Pressure (Absolute)</i>	41.43 kg/sq. cm
4.2.7	<i>Critical Density</i>	0.507 g/cc
4.2.8	<i>Specific Heat of Liquid at 30°C</i>	1.508 4 kJ/kg-K
4.2.9	<i>Specific Heat of Vapour at Constant Pressure (1 Atm. at 30°C)</i>	0.879 9 kJ/kg-K
4.2.10	<i>Ratio of Specific Heat (C_p/C_v) at 1 Atm.</i>	1.004
4.2.11	<i>Latent Heat of Vapour-ization at Boiling Point</i>	214.96 kJ/kg
4.2.12	<i>Thermal Conductivity of Liquid at 25°C</i>	81.9 mw/m.k
4.2.13	<i>Thermal Conductivity of Vapour at 25°C and 1 Atm</i>	14.05 mw/m.k
4.2.14	<i>Dielectric Constant of Vapour at 20°C and 1 Atm</i>	1.025
4.2.15	<i>Solubility of HFC-134a in Water at 25°C and 1 Atm</i>	0.15 weight %
4.2.16	<i>Solubility of Water in HFC-134a at 25°C</i>	0.11 weight %
4.2.17	<i>Viscosity of Liquid at 25°C</i>	0.202 Centipoise
4.2.18	<i>Viscosity of Liquid at 30°C</i>	0.190 Centipoise
4.2.19	<i>Viscosity of Vapour at 25°C and 1 Atm</i>	0.012 Centipoise
4.2.20	<i>Viscosity of Vapour at 30°C and 1 Atm</i>	0.0126 Centipoise
4.2.21	<i>Ozone Depletion Potential (ODP)</i>	0

- 4.2.22 *Halocarbon Global Warming Potential (HGWP)* 0.285
- 4.2.23 *Global Warming Potential (GWP)* 1 300
(100 yr./TH. For CO₂, GWP = 1)
- 4.2.24 *Toxicity AEL* 1 000 ppm (v/v)
(8 and 12 h TWA)

4.3 Chemical Properties

4.3.1 HFC-134a vapours will decompose when exposed to high temperature from flames or electric resistance heaters. Decomposition may produce toxic and irritating compounds, such as hydrogen fluoride. The pungent orders will irritate the nose and throat and generally force people to evacuate the area. Therefore, it is important to prevent decomposition by avoiding exposure to high temperatures.

4.3.2 HFC-134a / Poly alkylene glycol (PAG) and HFC-134a / Polyol ester (POE) solutions have acceptable chemical stability. HFC-134a molecule is as chemically stable as CFC-12. HFC-134a and CFC-12 are chemically compatible with each other, this means they do not react with each other to form other compounds. However, when the two materials are mixed together, they form azeotrope, which is difficult to separate. These mixtures can not be separated in an on-site re-cycle machine or in the typical facilities of an offsite reclaiming. Mixtures of HFC-134a and CFC-12 will usually have to be disposed of by incineration.

4.3.3 HFC-134a is compatible with steel, copper, aluminium and brass.

4.3.4 Incompatibility

Finely divided metals, magnesium and alloys containing 2 percent magnesium. It can react violently in contact with alkali or alkali earth metals such as Na, K, or Ba.

4.4 Fire and Explosion Properties

4.4.1 Auto Ignition Temperature, 770°C

4.4.2 Flammability

HFC-134a is non-flammable at ambient temperature and atmospheric pressure. However, it may be combustible at pressures as low as 5.5 psig at 177°C. When mixed with air at concentrations generally greater than 60-vol. percent air.

4.5 Corrosion Properties

Not-corrosive.

5 TOXIC INFORMATION AND HEALTH EFFECTS

5.1 Toxicity

HFC-134a has very low acute and subchronic inhalation toxicity and is not genotoxic.

5.2 Routes of Entry

Inhalation, skins and eye contact.

5.3 Health Effects

5.3.1 Inhalation

HFC-134a poses no acute or chronic hazard when exposures are maintained below recommended acceptable exposure limits (AEL) of 1 000 ppm on 8 or 12 hour time-weighted average (TWA) established by AIHA.

NOTE — AEL is an airborne inhalation exposure limit that specifies time-weighted average concentrations to which nearly all workers may be repeatedly exposed without adverse effects.

5.3.2 Asphyxiation

Inhaling high concentrations of HFC-134a vapour may cause temporary nervous system depression with anesthetic effects such as dizziness, headache, confusion and loss of consciousness. It can act as asphyxiant by limiting available oxygen. Higher exposures to vapours may cause temporary alteration of the heart's electrical activity with irregular pulse, palpitation or inadequate circulation. Inhaling higher concentrations of HFC-134a vapour may cause cardiac irregularities and possibly cardiac arrest.

5.3.3 Skin and Eye Contact

At room temperature, HFC-134a vapours have little or no effect on the skin. However, in liquid form, HFC-134a can freeze skin or eyes on contact causing frostbite.

6 PERSONAL PROTECTIVE EQUIPMENT

6.1 General

Personal protective equipment is not an adequate substitute for good, safe working conditions. Adequate ventilation and intelligent conduct on the part of employees is essential. One should keep firmly in mind that personal protective equipment protects only the person wearing it, and other unprotected workers in the area may be exposed to danger.

6.2 Non-respiratory Equipment

Personal protecting equipment should include non-respiratory equipment like splash proof safety goggles and face shield when working with liquid for eye protection. Where exposure to cold equipment vapours or liquid may occur, employees should wear special clothing designed to prevent the freezing of body

tissues. All protective clothing (suits, shirts with long sleeves, insulated gloves) should be clean, available each day, and put on before work. Trousers should be worn outside boots or overhigh top shoes to shed spilled liquid.

6.3 Respiratory Equipment

If a large release of HFC-134a vapour occurs, such as from a large spill or leak, the vapours may concentrate near the floor or low spots and displace the oxygen available for breathing, causing suffocation. An approved self contained breathing apparatus with a full face piece operated in positive pressure mode should be used when entering tanks and other areas where vapours might exist.

7 STORAGE, HANDLING, LABELLING AND TRANSPORTATION

7.1 Storage

7.1.1 General Precautions

7.1.1.1 HFC-134a must be stored to avoid contact with heat, flames, sparks and air.

7.1.1.2 Vessels, containers, transfer lines, pumps and other equipment should not be exposed to high temperature sources (such as welding, brazing and open flame) until they have been thoroughly cleaned and found free of vapours. Any maintenance job on such equipment should be done under the variety of safety work.

7.1.1.3 Only non-sparking tools and equipment should be used while opening and closing containers of HFC-134a.

7.1.1.4 The building shall have good low and high level natural ventilation. In areas where natural ventilation is not possible, forced ventilation equipment should be installed.

7.1.2 Bulk Storage

7.1.2.1 The storage tanks shall be designed as per standard code.

7.1.2.2 Storage tanks should be equipped with pressure gauge, liquid level gauge, safety release valves and excess flow valves.

7.1.2.3 Storage tanks should normally be evacuated at the start of filling, and should never be filled while under positive air pressure.

7.1.2.4 Tank pressure should never be allowed to exceed 300 psig when filling with HFC-134a. Relief devices on the tanks usually prevents this.

7.1.2.5 Tank pressures should be monitored routinely.

7.1.2.6 Air lines should never be connected to storage tanks.

7.1.3 Storage of Cylinders

7.1.3.1 The Cylinders of HFC-134a should be kept out of direct sunlight, particularly in warm weather. HFC-134a expands significantly when heated, thereby reducing the amount of vapour space left in the cylinder. Once the cylinder becomes liquid full, any further rise in temperature can cause the cylinder to burst, resulting in serious personal injury.

7.1.3.2 Never allow the cylinders to get warmer than 52 °C.

7.1.3.3 Cylinders should always be raised above dirt or damp floors to prevent rusting.

7.1.3.4 The storage area should be away from corrosive chemicals or fumes to avoid damaging effects on the cylinder and threaded area of the valve. The cylinders of HFC-134a should be kept in cool, dry and properly ventilated areas.

7.2 Handling

7.2.1 General

7.2.1.1 HFC-134a should be handled wearing an approved self contained breathing apparatus, chemical resistance gloves and safety goggles and other protective clothing (see 6).

7.2.2 Handling of Cylinders

7.2.2.1 Before filling the cylinder with HFC-134a, check and confirm its validity. It shall have valid test certificate from the concerned authorities.

7.2.2.2 Cylinders should never be subjected to rough handling or to abnormal mechanical shock such as dropping, bumping, dragging or sliding. They should be kept in vertical position.

7.2.2.3 Lifting magnet or sling (rope or chain) which may produce sparks should not be used.

7.2.2.4 While handling by crane or derrick, a safe platform or cradle should be used.

7.2.2.5 Cylinders of HFC-134a whether empty or filled should not be used as rollers, supports or for any purpose other than to carry HFC-134a.

7.2.2.6 Protect cylinders from any object that will result in abrasion in the surface of the metal.

7.2.2.7 Never tamper with the safety devices in the valves.

7.2.2.8 Use only standard colour code for HFC-134a cylinders.

7.2.2.9 Before evacuating cylinders, any remaining refrigerant should be removed by a recovery system.

7.2.2.10 Vacuum pump discharge lines should be free

of restrictions that could increase discharge pressures above 15 psig and result in the formation of combustible mixtures.

7.2.2.11 Cylinders should normally be evacuated at the start of filling, and should never be filled while under positive pressure.

7.2.2.12 Filled cylinders should periodically be analyzed for air.

7.2.2.13 Empty cylinders should be stored separately from filled cylinders and fasten empty tag on cylinders immediately upon emptying.

7.3 Labelling

7.3.1 Each vessel containing HFC-134a should carry an identification label or stencil.

7.3.2 Label should be as per rules and regulations.

7.4 Transportation

7.4.1 Labelling

Labels : Hazard class 2.2 should be displayed on the transport vehicle.

- a) Liquefied gas : Tetrafluoro ethane
- b) UN No. : 3159

7.4.2 Predeparture

7.4.2.1 Prior to and after loading, the drivers must take a complete inspection of the vehicle to ensure that it meets all performance safety requirements and is roadworthy for transporting HFC-134a. A few of the numerous items that are checked are the lights, tyres, suspensions and brakes.

7.4.2.2 The driver should maintain a log entry book for critical parameters like pressure etc, during transit.

7.4.2.3 Ensure availability of emergency kit on the vehicle.

7.4.2.4 Ensure availability of Transport Emergency Card (TREM Card) and Instruction Manual during transportation in the vehicle.

7.4.3 During Transportation

7.4.3.1 Driver should follow specified route only, maintain speed limit, never park the truck near residential areas, drive truck carefully and observe all rules and signals, avoid overtaking of moving vehicles and do not leave the truck without watch at any time.

7.4.3.2 The trucks should not be parked under direct sunshine for long duration.

7.4.3.3 No repairs involving gas cutting, welding etc, should be done during transportation period. If required at all, repairs should be done by authorized and

competent personnel of Maintenance Department/ Plant who are deputed by manufacturer/supplier.

7.4.3.4 The driver should physically inspect complete mounting periodically and immediately report any abnormality to the supplier.

7.4.3.5 In case of emergency (for example leaks, fires etc), the following measures should be taken immediately:

- a) Stop the engine,
- b) Notify police and fire brigade immediately,
- c) Mark roads, warn other road users,
- d) Keep public away, and
- e) In case of leak, avoid open flame near spillage.

7.4.4 Drivers Training

7.4.4.1 The basics of any effective safety programme for transportation of HFC-134a is adequate training.

7.4.4.2 Each driver must be carefully selected and receive adequate amount of classroom training, audio-visual instructions and job training.

7.4.4.3 The driver must carry material safety data sheet with each consignment of HFC-134a.

7.4.4.4 Systematic training/retraining/reviews must be carried out to ensure:

- a) Safe driving methods,
- b) Actions to be taken during emergency,
- c) Proper use of fire extinguishers, kits, TREM cards, instruction manual etc, and
- d) Communication with manufacturer/supplier.

8 SPILLAGE, LEAKAGE AND WASTE DISPOSAL

8.1 Spillage/Leakage

8.1.1 Frequent inspection of equipment, containers and vessels containing HFC-134a should be made to detect or prevent leaks.

8.1.2 If spills or leaks of HFC-134a occur, only properly protected personnel should remain in the area and entry to others should be prohibited.

8.1.3 Every organisation handling HFC-134a must form Emergency Response Team which is available round the clock. Spills or leaks should be handled by Emergency Response Team specifically trained to handle emergency situations.

8.1.4 In case of major spill or leak, the area should be evacuated immediately. Vapours may concentrate near the floor, displacing available oxygen.

8.1.5 The area of leak must be ventilated using blowers or fans to circulate the air at floor level.

8.1.6 Use self contained breathing apparatus while going to close valves or repair source of leak.

8.1.7 Avoid open flames near spillage.

8.1.8 If source of leak is a cylinder and the leak can not be stopped in place, remove the leaking cylinder to a safe place in the open air and repair leak.

8.1.9 Prevent liquid from entering sewers, sumps or pit areas, since vapour can create suffocating atmosphere. Capture material for recycle or destruction if equipment is available.

8.2 Leak Detection

8.2.1 Leak detection is important for refrigerant conservation, equipment protection and performance, reduction of emissions and protection of those coming in contact with the system.

8.2.2 No leak testing should be performed with HFC-134a and air in the system. HFC-134a may be safely pressured with dry nitrogen.

8.2.3 Leak detectors may be used for pin pointing specific leaks or for monitoring an entire room on a continuous basis.

8.2.4 There are two types of leak detectors, leak pinpointers and area monitors. Before purchasing either type, several equipment factors should be considered, including detection limits, sensitivity and selectivity. Fluorescent dyes compatible with lubricant and HFC-134a can also be added to a system for leak detection.

8.3 Waste Disposal

Disposal refers to the destruction of used HFC-134a. Disposal may only be necessary when HFC-134a has become badly contaminated with other products and no longer meets the acceptance specifications of reclaimers. Be sure to check the qualifications of any firm before sending them used HFC-134a.

9 RECOVERY, RECLAMATION AND RECYCLING

9.1 Recovery

9.1.1 Recovery and re-use of HFC-134a is important from an environmental stand point.

9.1.2 HFC-134a may be recovered from refrigeration equipment using on-site equipment or portable recovery devices containing compressor and an air cooled condenser.

9.1.3 Known venting of HFC-134a during the maintenance, servicing or disposal of refrigeration equipment should not be done.

9.2 Reclamation

Reprocessing of used HFC-134a should be done as far as possible.

9.3 Recycling

Refrigerant recycle refers to the reduction of used refrigerant contamination using devices that reduce oil, water, acidity and particulates.

10 FIRE PREVENTION AND FIRE FIGHTING

10.1 Fire Prevention

10.1.1 HFC-134a is not flammable at ambient temperature and atmospheric pressure. Avoid open flames near source of leak.

10.1.2 Cylinders may rupture under fire conditions and decomposition of HFC-134a may occur. This will produce toxic and irritating compounds.

10.2 Fire Fighting

10.2.1 In case of fire in the area where cylinders are stored, cool cylinders with water spray. Self contained breathing apparatus with full face-piece and protective clothing may be required if cylinders rupture or release under fire conditions.

10.2.2 Use appropriate fire extinguishing media as appropriate for combustibles in the area.

11 TRAINING AND HEALTH MONITORING

11.1 Employee Education and Training

11.1.1 Training

11.1.1.1 Training shall cover all aspects and potential hazards that the particular operator is likely to encounter. Following areas should be covered in the training:

- a) Potential health hazards of HFC-134a,
- b) Human health effects,
- c) Site safety regulations,
- d) Emergency response procedures (leaks/spills/evacuations),
- e) Use of protective clothing/breathing apparatus,
- f) Accidental release measures,
- g) Fire fighting, and
- h) First aid.

11.1.1.2 In addition, individuals shall receive specific training in their areas of activities. Refresher courses should be arranged on a periodic basis.

11.2 Health Monitoring

11.2.1 Personal Hygiene

11.2.1.1 Eating, drinking and storing of food near the place where HFC-134a is handled should be prohibited.

11.2.2 Medical Examination

11.2.2.1 Annual medical checkup of all the employees as required by laws/regulations (Factories Act), State Factories Rules should be carried out.

12 FIRST AID

12.1 Inhalation

12.1.1 Inhalation of HFC-134a vapours causes irritation and at high concentrations may result in asphyxiation, cardiac irregularities and possibly cardiac arrest.

12.1.2 Intentional misuse or deliberate inhalation of HFC-134a may cause death without warning. This practice is extremely dangerous.

12.1.3 If high concentrations are inhaled, immediately remove the person to fresh air. Keep person calm. If not breathing give artificial respiration. If breathing is difficult give oxygen. Call a physician.

12.2 Skin Contact with Liquid HFC-134a

Immediately flush skin with plenty of water for at least 15 min. Remove contaminated clothing.

Clothing may adhere to the skin in case of freeze burns. In case of frostbite, flush the exposed area with luke warm water or gently warming affected area. Wash contaminated clothing before reuse. If symptoms (irritation or blistering) develop get medical attention.

12.2.1 Eye Contact

In case of contact, immediately flush eyes with plenty of water for at least 15 min, lifting eyelids occasionally to facilitate irrigation. Seek medical attention immediately.

12.2.2 Antidote/Dosage

Because of possible disturbance of cardiac rhythm, Catecholamine drugs, such as Epinephrine, should be considered under strict medical advice only as a last resort in life threatening emergencies.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Industrial Safety and Chemical Hazards Sectional Committee, CHD 8

<i>Organization</i>	<i>Representative(s)</i>
National Safety Council, Navi Mumbai	SHRI K. C. GUPTA (<i>Chairman</i>)
Airport Authority of India, New Delhi	REPRESENTATIVE
Atomic Energy Regulatory Board, Mumbai	SHRI P. K. GHOSH
Bhabha Atomic Research Centre, Mumbai	DR B. N. RATHI
Central Boiler Board, New Delhi	REPRESENTATIVE
Century Rayon, Thane	SHRI H. G. UTTAMCHANDANI
	SHRI S. K. MISHRA (<i>Alternate</i>)
Central Leather Research Institute, Chennai	REPRESENTATIVE
Central Mining Research Institute, Dhanbad	SHRI J. K. PANDEY
Central Warehousing Corporation, New Delhi	REPRESENTATIVE
Confederation of Indian Industries, New Delhi	REPRESENTATIVE
Department of Explosives, Nagpur	REPRESENTATIVE
Department of Industrial Policy and Promotion, New Delhi	DR D. R. CHAWLA
Development Commissioner (SSI), New Delhi	REPRESENTATIVE
Directorate General of Health Services, New Delhi	REPRESENTATIVE
Directorate General Factory Advice Service & Labour Institute, Mumbai	DR A. K. MAJUMDAR
Directorate of Industrial Safety and Health, Mumbai	SHRI S. P. RANA (<i>Alternate</i>)
Directorate General of Mines Safety, Dhanbad	REPRESENTATIVE
	DIRECTOR OF MINES (MSE)
	DEPUTY DIRECTOR OF MINES SAFETY (<i>Alternate</i>)
Employees State Insurance Corporation, New Delhi	REPRESENTATIVE
Excel Industries Ltd, Mumbai	REPRESENTATIVE
Hindustan Aeronautics Ltd, Bangalore	REPRESENTATIVE
Hindustan Lever Ltd, Mumbai	SHRI B. B. DAVE
	SHRI ADITYA JHAVAR (<i>Alternate</i>)
Indian Institute of Chemical Technology, Hyderabad	SHRI S. VENKATESWARA RAO
Indian Chemical Manufacturers Association, Mumbai	SHRI V. N. DAS
	SHRI A. A. PANJWANI (<i>Alternate</i>)
Indian Drugs and Pharmaceuticants Ltd, Rishikesh	REPRESENTATIVE
Indian Petrochemical Corporation Ltd, Vadodara	SHRI P. VIJAYRAGHAVAN
	SHRI M. R. PATEL (<i>Alternate I</i>)
	SHRI A. V. SARATHY (<i>Alternate II</i>)

<i>Organization</i>	<i>Representative(s)</i>
Indian Space Research Organization, Sriharikota	SHRI P. N. SANKARAN SHRI V. K. SRIVASTAVA (<i>Alternate</i>)
Indian Toxicology Research Centre, Lucknow	DR VIRENDRA MISHRA DR V. P. SHARMA (<i>Alternate</i>)
Ministry of Defence (DGQA), Kanpur	SHRI M. S. SULTANIA SHRI SUJIT GHOSH (<i>Alternate</i>)
Direcorate of Standardization, Ministry of Defence, New Delhi	SHRI P. S. AHUJA LT- COL TEJINDER SINGH (<i>Alternate</i>)
Ordnance Factory Board, Kolkata	DR D. S. S. GANGULY SHRI R. SRINIVASAN (<i>Alternate</i>)
Ministry of Defence (R&D), Kanpur	DR A. K. SAXENA DR RAJINDRA SINGH (<i>Alternate</i>)
Ministry of Environment & Forest, New Delhi	REPRESENTATIVE
National Institute of Occupational Health, Ahmedabad	REPRESENTATIVE
National Organic Chemical Industries Ltd, Thane	DR B. V. BAPAT SHRI V. R. NARLA (<i>Alternate</i>)
National Safety Council, Navi Mumbai	SHRI P. M. RAO SHRI D. BISWAS (<i>Alternate</i>)
Oil Industry Safety Directorate, New Delhi	SHRI S. K. CHAKRABARTI SHRI V. K. SRIVASTAVA (<i>Alternate</i>)
Safety Appliances Manufacturers Association, Mumbai	REPRESENTATIVE
Standing Fire Advisory Council, Ministry of Home Affairs, New Delhi	REPRESENTATIVE
Steel Authority of India Ltd, Ranchi	REPRESENTATIVE
SIEL Chemical Complex, New Delhi	REPRESENTATIVE
Southern Petrochemical Industries Corporation Ltd, Chennai	SHRI V. JAYARAMAN SHRI S. MURUGANANDAM (<i>Alternate</i>)
Tata AIG Risk Management Services Ltd, Mumbai	SHRI URMISH D. SHAH
BIS Directorate General	SHRI S. K. CHAUDHURI, Director & Head (CHD) [Representing Director General (<i>Ex-officio</i>)]

Member Secretary
SHRI N. K. PAL
Director (CHD), BIS

